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(54) VIBRATION ISOLATOR WARES AND VIBRATION ISOLATION SYSTEMS COMPRISING SAME

(72) Lilley, Daniel T., Jr.;
Berger, Elliott H.,
U.S.A.

(73) Granted to E-A-R Corporation
U.S.A.

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ABSTRACT OF THE DISCLOSURE

Disclosed herein are vibration isolator wares composed of resilient polymeric damping materials. The isolator wares of the invention are adapted to be interposed between a support surface and a ware to be vibration isolated, thereby to minimize transmission of vibrational energy therebetween. The vibration isolator wares of the invention are particularly suited for vibration isolation of relatively low-mass wares such as high fidelity phonograph turntables, laboratory balances or microscopes. In the accomplishment of these purposes, the vibration isolator wares of the invention are constructed in a manner such that, upon installation in a vibration isolation system, substantial force components of shear and compression are generated within the resilient polymeric damping material of construction thereof.

BACKGROUND OF THE INVENTION

Field of the Invention: The present invention relates broadly to vibration isolation and is more particularly concerned with polymeric vibration isolator wares and vibration isolated systems comprising such wares.

The Prior Art: Vibration isolation of various types of machinery and equipment has been practiced for a number of years but limitations in performance, due to inherent deficiencies in known systems, have often prevented realization of full and effective isolation. This is particularly so as regards the problem of vibration isolation of relatively low mass wares of about 25 kg or less. Examples of such relatively low mass wares, for which suitable vibration isolation is often essential for good performance, service life or both, include, but are not limited to: phonograph turntables, microscopes, cameras, photographic enlargers, laboratory balances, centrifuges, vibration sensitive electronic equipments and the like.

One reasonably successful conventional solution in the vibration isolation of such relatively low mass wares has been to affix a relatively large mass, for instance a marble or stone block, to the ware of relatively small mass, thereby to provide an overall composite inertial mass of considerable weight. This relatively heavy composite inertial mass is then conventionally supported on rubbery isolation elements which are subjected to the substantial compression forces wrought thereupon by the inertial mass. Needless to say, however, such vibration isolating techniques are often found to be excessively complex, expensive and bulky, particularly with

respect to those relatively low mass wares which are required to be readily transportable from one location to another.

Another prior approach with respect to vibration isolation of low mass wares is to interpose a plurality of light metal coil springs or very soft, thick and resilient elastomeric elements between a support surface and the ware to be vibration isolated. The vibration isolation elements are, in such schemes, loaded essentially completely in compression between the supported ware and the support surface. Such vibration isolation systems have been usually found to be reasonably effective in terms of acceptable vibration isolation at frequencies on the order of about 10 Hz and above. However, should such systems be excited at or near the system resonance frequency, the vibrational displacement of the isolated ware can become very large due to the phenomenon of amplification. For purposes of the present discussion, the natural frequency of such resiliently mounted vibration isolated systems can be taken as the frequency at which the isolated ware will vibrate by itself if a force is exerted on the system and then released. When the system is excited at or near resonance frequencies (and often at harmonics thereof), the energy stored within the plural vibration isolation elements is released in phase with the forcing vibrations, thus leading to amplification rather than diminution of the vibrational displacement of the isolated ware. This phenomenon, of course, is extremely undesirable in that not only do the vibration isolation elements fail to act in the desired manner, they instead act to exacerbate vibration of the isolated ware. Thus, at or about system natural frequencies, or harmonics thereof, it is

often found that it is better to use no isolation elements at all rather than the multiple lightweight springs or soft resilient elastomeric elements of the foregoing discussion.

In accordance with the present invention, the aforementioned difficulties have been substantially completely eliminated or, at least, vastly ameliorated.

OBJECTS OF THE INVENTION

It is a principal object of the invention to provide novel vibration isolator wares.

It is another object of the invention to provide novel vibration isolator wares particularly adapted for use in the vibration isolation of relatively low mass wares.

It is another object of the invention to provide novel lightweight vibration isolator wares adapted for use in the vibration isolation of relatively low mass wares and wherein amplification factors of greater than about 2 are avoided upon excitation at system natural frequencies.

It is another object of the invention to provide vibration isolator wares adapted for vibration isolation of relatively low mass wares wherein the need for provision of substantial additional mass is avoided.

It is another object of the invention to provide novel vibration isolator wares which provide good vibration isolation properties in systems equipped therewith over a broad range of excitation frequencies.

It is another object of the invention to provide novel vibration isolator wares which can be used in combination with original equipment vibration isolator wares already forming part of the ware to be vibration isolated, thereby to avoid or reduce problems due to amplification phenomena.

It is still another object of the invention to provide novel vibration isolated systems which require no substantial increases in the mass of the vibration isolated wares thereof.

It is another object of the invention to provide a novel method for the vibration isolation of wares desired to be isolated from vibration transmitted thereto by contact thereof with a vibrating ware or by impingement of airborne acoustic energy thereon.

Other objects and advantages of the invention will in part be obvious and will in part appear hereinafter.

The vibration isolator ware of the invention is constructed of a solid, resilient polymeric damping material having a loss factor, η, of at least 0.2 at 20°C and at 100 Hz excitation frequency. Structurally, the ware comprises a plate element, support means depending from the plate element adapted to support and space said plate element from a support surface and a ware-supporting boss element extending upwardly from the plate element. The support means also functions to define an unsupported portion of the plate element and the boss element has a free end which extends upwardly from the unsupported portion of the plate element.

In particular the boss element may be of a size and location upon the plate element such that, when interposed between a support surface and a ware to be vibration isolated, the static load exerted by the isolated ware upon said boss element is caused to be nonuniformly directed through said plate element, thereby to generate substantial components of force of shear and compression therewithin.

The vibration isolated system of the invention comprises a support surface, a plurality of the vibration isolator wares of the invention interposed between the surface

and a ware to be vibration isolated. In particular the isolator wares are supported upon the surface and the ware to be vibration isolated is supported upon the boss elements of the isolator wares and more particularly on the free ends of the boss elements. The number of vibration isolator wares employed is particularly selected with respect to the mass of the supported isolated ware such that there results substantial vertical deflection of each of the isolator wares due to the static load of the isolated ware supported thereby.

In particular the number of isolator wares present is such that substantial static loading of each is provided by the mass of the ware supported thereon, thereby to generate within the polymeric damping material of each of the isolator wares substantial components to shear and compression.

The method of the invention comprises providing a ware desired to be vibration isolated and a support surface therefor and interposing between said support surface and said ware a plurality of vibration isolator wares of the invention, the number of such isolator wares so interposed being selected with respect to the mass of the supported isolated ware such that there results substantial vertical deflection of each of said isolator wares due to the static load imposed thereupon by the isolated ware.

In particular the number of wares interposed is selected such that substantial loading of each is provided by the mass of the ware supported thereon, thereby to generate within the polymeric damping material of each of the isolator wares substantial components of shear and compression.

BRIEF DESCRIPTION OF THE DRAWING

Figure 1 hereof is a schematic, diagrammatic, longitudinal and partially sectional view of a vibration isolator ware in accordance with the invention.

Figure 2 is a schematic, diagrammatic, partially sectional top view of the isolator ware of Figure 1.

Figure 3 hereof is a schematic, diagrammatic, longitudinal and partially sectional view of the ware of Figure 1 shown in an operational environment wherein it is interposed between a support surface and a ware supported thereon, thereby to generate components of compressive and shear forces therein.

Figure 4 hereof is a graphic representation of comparative vibration isolation performances, over a range of excitation frequencies, of systems produced in accordance with the procedure of Example 1 and wherein a steel plate is: (a) unisolated; (b) vibration isolated by means of isolator wares in accordance with the invention; and (c) vibration isolated by means of a type of

commercially available vibration isolator ware of the prior art.

Figure 5 hereof is a graphic representation of foot-fall excited vibration isolation results achieved in Example 2 hereof wherein a vibration isolated stereo phonograph turntable of commerce is tested and compared to the same turntable in which the plural original equipment isolation elements are retained and isolation wares in accordance with the invention are added in series therewith.

Figure 6 hereof is a schematic, diagrammatic, long-itudinal section of another embodiment of the vibration iso-lator wares of the invention.

Figure 7 is a graphic representation comparing the performances of two types of commercially available vibration isolator wares against that of isolator wares in accordance with the invention in the vibration isolation of a steel block.

Figure 8 is a graphic representation disclosing the vibration isolation characteristics, over a range of excitation frequencies, of a vibration isolated laboratory balance of com-merce in which the performance of one type of commercially available vibration isolator ware is compared against the per-formance of vibration isolator wares in accordance with the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The vibration isolator wares of the present invention are constructed of a solid, resilient polymeric damping material having a loss factor, η, of at least 0.2 at 20°C and 100 Hz excitation frequency. By "solid" it is meant that the material of construction be essentially non-porous or unfoamed. By "resilient" it is meant that the material of construction tends

to substantially recover its original shape and size when subjected momentarily to a low rate stress of sufficient magnitude to induce a strain therein and the stress then removed. For purposes of the present invention, the loss factor, η, of solid resilient polymeric damping compositions can be suitably determined by any of the procedures disclosed in "Temperature-Frequency Dependence of Dynamic Properties of Damping Materials", D. I. G. Jones, Journal of Sound and Vibration, (1974) 33(4), p.p. 451-470. In a preferred embodiment of the present invention, the loss factor of the polymeric material of construction will be, under the test conditions outlined above, at least 0.5.

Many polymers, copolymers, interpolymers, and mixtures thereof can be formulated or compounded or otherwise prepared in such manner as to give rise to solid resilient polymeric damping compositions having the required loss factor properties for use in the invention. Examples of particular polymers which are generally susceptible of such formulation or polymerization are, for instance, polyvinylchloride, butyl rubber, polyurethane, butadiene-acrylonitrile rubber, polyfluorotrichloroethylene, polysulfide rubber, polynorbornene GR-S rubber and the like.

Suitable loss factor characteristics can often be imparted to polymers by compounding thereof with one or more of various flexibilizers, external plasticizers, internal plasticizers or any of the foregoing in combination with suitable loading of the polymer with non-reinforcing fillers such as graphite, calcium carbonate, pulverulent glass, amorphous silica, talc, alumina, antimony oxide and the like. Accordingly, the particular manner in which a given polymeric material

is provided with the essential loss factor property is not generally critical with respect to the invention. A resilient polymeric damping material found especially suitable for construction of the isolator wares of the invention is an externally plasticized, solid, resilient polyvinylchloride composition sold commercially under the trade designation, Isodamp®, by E-A-R Corporation, Indianapolis, Indiana. This polyvinylchloride composition comprises a homopolymeric vinyl chloride resin, about 118 weight parts per hundred parts of said resin of a highly aromatic organic plasticizer and relatively small quantities of miscellaneous other additives such as colorants, pigments and stabilizers. This composition has a loss factor of about 0.8 at 20°C and under excitation frequency of 100 Hz and is available in sheet form of various thicknesses or in the form of granules suitable for use in thermoforming thereof into finished wares of desired size and shape.

Structurally, the isolator wares of the invention are adapted to support the ware to be vibration isolated in such manner that the static load imposed upon the isolator ware is nonuniformly directed through a substantial portion of the material thereof, thereby to generate substantial components of shear and compression forces within the damping material. By this dual loading of the isolator, in other words, loading thereof in both compression and shear, there results excellent high frequency vibration isolation and, of equal or greater significance, a marked reduction in the aforementioned amplification phenomenon at or about the natural frequency of the resulting isolated system.

Reference is now made to Figures 1, 2, 3 and 6 hereof, wherein like reference numerals refer to like structures. The vibration isolator ware of the invention, which is constructed of a solid, resilient polymeric damping material as described hereinbefore, broadly comprises an intermediate plate element 1 having support means 2 depending therefrom, said support means being located peripherally with respect to said plate element 1 so as to provide said element 1 with an essentially unsupported central portion 5. In the embodiments of the invention shown in Figures 1 through 3 and 6 said depending support means 3 takes the form of a number of foot pods 4 disposed about the periphery of and depending from the lower surface of the plate element 1 thereof. In alternative embodiments of the invention, however, said support means 3 can also take the forms of a continuous or interrupted ring or ridge depending from the periphery from the periphery of the plate element 1. Obviously, by any of the aforementioned constructions of the support means 3, plate element 1 is provided with an essentially unsupported central portion 5 which is vertically spaced from a suitable support surface 20 (Figures 3 and 6). As best shown in Figures 1 and 6, the lower surface of the unsupported central portion 5 of plate element 1 may comprise a concavity 6, thereby to facilitate flexure thereof upon static loading of the isolator ware.

Arising from the upper surface of central portion 5 of plate element 1 is a boss element 7, the free end 9 of which is adapted to receive in supporting relationship thereon a ware 30 (Figure 3) to be vibration isolated. In a preferred embodiment of the invention, referring particularly to Figures 1 through 3, a rigid member 11 is interposed between the free

end 9 of boss element 7 and the ware 30. It is the principal role of said rigid member 11 to evenly distribute the load imposed by ware 30 upon the free end 9 of boss element 7. Accordingly, said rigid member 11 should be of sufficient size as to substantially completely overlie the surface of said free end 9. In the interests of facile assembly of the isolated system and to prevent accidental slippage or displacement of the rigid member 11, said member 11 is desirably provided with a central depending stud 3 which is received in a recess 15 provided in the center of free end 9 of boss element 7. Alternative means for affixing the rigid member 11 to the boss element 7 will be apparent to those skilled in the art. For instance, said member 11 can also be in the form of a fender washer and the free end 9 of boss element 7 can be provided with an upstanding integral stud composed of the same material as that of the remainder of the vibration isolation ware, said stud to be received into the central aperture of the washer.

An important relationship to be established in the vibration isolator ware of the invention is that shown to exist at the juncture of boss element 7 and plate element 1. Thereat, in Figure 6, it will be seen that the cross-sectional area of element 7 is no greater than that of the unsupported portion 5 of said plate element 1. This relationship is important in order to ensure that a substantial shear component is generated in the material of construction of the vibration isolator ware upon static loading thereof with the ware 30. In the embodiment of Figures 1 through 3, the cross-sectional area of the boss element 7, at its juncture with plate element 1, is shown

to be substantially less than that of the unsupported central portion 5 of said plate element 1. As can be best seen by comparison of Figures 1 and 3, upon appropriate static loading of the isolation ware of the invention, the boss element 7 and unsupported central portion 5 of plate element 1 are deflected downwardly relative to the supported periphery of said element 1. This generates a substantial shear load in portion 5 of plate element 1 as is evidenced by the downward bowing of unsupported portion 5 thereof depicted in Figure 3. The support means 2 and boss element 7 of the vibration isolator wares of the invention are, on the other hand, placed largely under compressive forces. This compression loading component expresses itself, in the construction depicted in Figure 3, as an outward bulging of the polymeric material forming the foot pods 4 and/or the material forming the boss element 7.

In order to achieve good vibration isolation, it is of consequence that the vibration isolator wares of the invention be substantially, but not excessively, statically loaded by ware 30. Such substantial loading is characterized by a readily discernible downward deflection of the boss element 7 upon loading of the isolator ware with the ware to be vibration isolated. Of course, it is abundantly obvious that the static loading of the isolator wares of the invention should not be so great as to cause "bottoming" of the unsupported portion 5 of plate element 1 against the support surface 20. For a given isolator ware and a ware 30 of a given mass, adjustment of said static loading can be generally had by due consideration and appropriate selection of the number of such isolator wares to be interposed between the support surface 20 and the vibration isolated ware 30. The loading will be further affected by the

particular polymer composition, resilience and stiffness of the particular isolator ware employed, its size and its specific geometry.

It is also preferred that the shear component of force generated in the polymeric material of construction be sufficient to provide a "shear factor" of at least about 6. For purposes of the invention, shear factor is represented by the quotient of the downward deflection measured at the free end 9 of boss 7 (datum A of Figures 1 and 6) divided by the downward deflection measured at the supported periphery of the upper surface of plate element 1 (datum B of Figures 1 and 6). These deflections can be determined readily during operations by use of suitable gauging apparatuses, such as dial indicators.

There follow a number of illustrative, non-limiting examples.

Example 1

In this example a steel plate having dimensions of about 28 cm x 28 cm x 2.5 cm and weighing about 15.87 kg. was vibration isolated employing the isolator wares of Figure 1 hereof. Said isolator wares were produced by injection molding of granular Isodamp® material. The major dimensions of said wares, in the unloaded state, were as follows:

Boss element 7, height: 0.64 cm
diameter: 1.43 cm

Plate element 1, thickness at periphery: 0.64 cm
thickness at center: 0.48 cm
diameter: 3.63 cm

Foot elements 4, number: 4
height: 0.64 cm
diameter at plate element 1: 0.87 cm

Overall unloaded height: 1.92 cm

In the present test no rigid members 11 were employed. The steel plate was supported above a support surface 20 by interposition therebetween of 4 of the isolator wares of the invention. Under this static loading, the downward deflection of boss elements 7 of each of the isolator wares was about 0.2 cm. The deflection at datum A was about 0.2 cm and the deflection at datum B about 0.02 cm, yielding a shear factor of about 10.

Support surface 20 was represented by a 181 kg. concrete block, which block was excited by means of an MB dynamic shaker table. The shaker table was operated, over a range of frequencies, in the vertical, or Y, axis. The vertical accelerations transmitted to the isolated steel plate were 30 were detected by means of a piezoelectric accelerometer (Bruel and Kjaer Type 4332, B and K Instruments, Cleveland, Ohio) affixed to the upper surface thereof, the output signals of which accelerometer were routed through a preamplifier and the vertical or Y circuit of an X-Y recorder. The shaker table vibration intensity and frequency was controlled by means of a sweep drive in circuit with a BFO which, in turn, drove both the power amplifier for the shaker table and the chart drive of the recorder. The vibration excitation frequency was continuously monitored by means of a digital frequency counter connected in parallel with the BFO.

Employing the apparatus as outlined above the plot appearing in Figure 4 hereof, identified as "INVENTION" therein, was achieved. A similar plot was produced for the same steel plate in an unisolated condition simply by removal of the isolator wares of the invention from the system ("UNISOLATED PLATE"). This results in an essentially 100% vibration transmission baseline plot against which the performances of the isolator wares

of the invention can be readily compared. As can be seen, minor amplification of low frequency vibration occurs utilizing the isolator wares of the invention, the amplification factor being less than 1.7. At frequencies above about 27 Hz, the vibration isolation achieved improves markedly.

Next, the vibration isolator wares of the invention were replaced with commercially available vibration isolator wares, each comprising a plastic cup base into which is threaded a dome composed of a polymeric material. The design of said device is such that the dome is placed substantially entirely in compression. The resulting "PRIOR ART" plot of Figure 4 pertaining to performance of this state-of-the-art ware discloses marked amplification of vibration at about 13 Hz. Said plot also discloses at least one additional peak representing substantial isolation reversal at about 38 Hz.

Example 2

In the present example, the vibration-isolated ware 30 employed was a phonograph turntable of commerce, a Yamaha YP-211, manufactured by Yamaha International, Buena Park, California. Comparison was made of the performance of the original equipment vibration isolation system supplied with the turntable comprising suspension of the turntable upon four butyl rubber mounts, against that provided by said original equipment isolation system used in consort with the vibration isolator wares of the invention of the same type as employed in Example 1. The weight of the turntable was approximately 5.5 kg. Since a serious vibration condition in phonograph turntables often results in the chattering of the stylus thereof across the surface of the record disk, it is apparent that provision of vibration isolation in the horizontal plane, or X axis, is of extreme importance in this application.

Accordingly, in the present example, acceleration levels were measured in the horizontal axis. Furthermore, the support surface 20 was defined by the turntable furniture cabinet and excitation was achieved by human footfall rather than by use of vibrator apparatus. Eight trials were accomplished and the averaged to assure uniformity. Figure 5 hereof discloses the resulting plots wherein it can be readily seen that, employing the as-supplied vibration isolation system, "STOCK ISOLATION SYSTEM", several amplification peaks were experienced at low frequencies. The most serious of these occurred at about 12.5 Hz and was of sufficient magnitude as to result in chattering of the stylus across the record disk.

Next, four isolator wares of the type utilized in Example 1 were interposed between the stock rubber mounts and the cabinet. The boss element 7 of each ware was downwardly deflected about 0.115 cm as a result of the static load imposed by the turntable. The shear factor was about 10. The resulting isolation plot, "INVENTION", disclosed markedly superior isolation over the range of frequencies encountered and discloses only minor amplification at the 12.5 Hz frequency.

Example 3

In this example the vibration-isolated ware 30 was represented by a steel block having a mass of about 19.95 kg. The apparatus and the procedures employed were similar to those of Example 1. However, the vibration isolator wares of the invention were of the type disclosed in Figure 6, the composition thereof being of Isodamp® material and the major dimensions of the injection molded wares being as follows:

Boss element 7, height: 0.3 cm
diameter: 1.29 cm

Aperture through boss element 7, height: 1.3
diameter: 0.61 cm

Plate element 1, height: 0.97 cm
diameter: (at top) 3.81 cm

Foot elements 4, number: 4
height: 0.97 cm
width at junction with plate element 1: 0.89

In isolating the ware 30 with the isolator wares of the invention, four of the isolator wares were interposed between the vibrator/support surface 20 and the ware 30. This resulted in a downward deflection of boss element 7 of each isolator ware of about 0.22 cm and a shear factor of about 6. Comparison of the vibration isolation performance of the wares of the present invention was made against two commercially available vibration isolator wares stated by the suppliers thereof to be specifically adapted for vibration isolation of laboratory apparatuses. The first of these, marketed by Fisher Scientific Company, Pittsburgh, Pennsylvania, comprises a fiberglass pad coated with a sealant. The second, marketed by Sargent-Welch Scientific Company, Skokie, Illinois, comprises a rigid plastic cup base containing a rubbery insert. The equipment arrangement employed was essentially the same as that of Example 1, accelerations being determined in the Y, or vertical, axis.

The plots appearing in Figure 7 disclose the isolation performances of the wares tested. As can be readily noted therefrom the wares of the invention ("INVENTION") provide substantially less amplification at resonance than either of the wares of the prior art ("PRIOR ART I and II") and, with respect to frequencies above about 35 Hz, are substantially equivalent in isolation capability.

Example 4

In this example a laboratory balance, Mettler Model B-5, Mettler Instrument Corporation, Hightstown, New Jersey, is employed as the vibration-isolated ware 30. Vibration isolation testing in the vertical or Y axis was achieved utilizing (a) no isolation wares ("UNISOLATED"), (b) commercially available isolation wares of the prior art ("PRIOR ART II"), and (c) isolation wares of the present invention and of the same type as those employed in Example 3 ("INVENTION"). The balance weighed approximately 6.8 kg. Three of the isolation wares of the invention were employed, the static load imposed by the balance thereon resulting in a downward deflection of boss element 7 of each of said wares of about 0.11 cm and a shear factor of about 6.3.

As is apparent from the plots appearing in Figure 8, the unisolated balance was not particularly sensitive to amplification at frequencies on the order of about 40 Hz or less. However, at frequencies of above about 40 Hz, vibration transmission into the apparatus was marked. Utilizing the isolation wares of the prior art, substantial amplification of low frequency vibrations into the balance was observed at about 20, 50 and 70 Hz, although at frequencies of above about 150 Hz, vibration isolation appeared to be somewhat improved over the unisolated balance. Now, referring to the INVENTION plot, it is to be noted that substantially no amplification of vibration transmission was experienced, that improvement in isolation begins to occur at about 20 Hz and that, thereafter, isolation achieved by the wares of the invention is markedly improved over the PRIOR ART II isolator wares throughout the

remainder of the range of frequencies employed in the test procedure, i.e., from about 20 Hz to about 200 Hz.

Obviously, many changes, modifications and alterations may be made in the vibration isolator wares and vibration isolated systems specifically disclosed hereinabove without departing from the essential spirit and scope of the invention. For instance, while the isolator wares specifically disclosed hereinbefore each comprise support means depending from the periphery of the plate element thereof, it is obvious that said support means can also depend from the central portion of the plate element, thereby to provide said plate element with an unsupported portion located at the periphery thereof. In such an embodiment, of course, the boss element would then extend upwardly from the unsupported peripheral portion of the plate element. This alternative embodiment of the invention would be essentially realized, for instance, by turning the wares of Figures 1 through 3 and 6 hereof upside down, and thus providing an embodiment in which the roles previously described for the boss elements 7 and foot pods 4 are reversed. As can be appreciated, under these reversed conditions the boss element 7 then serves as the support element spacing the plate element 1 from the support surface 20. Correspondingly, the foot pods 4 then serve, in the aggregate, as the boss element to receive thereon the ware 30 to be vibration isolated.

Also, while the invention has thus far been disclosed only in terms of wares 30 of a type desired to be protected from vibrations transmitted thereto through a vibratile support surface 20, it is equally obvious that the ware 30 can as well be

the vibratile component in the system while the support surface 20 can be the element desired to be protected against the transmission of vibration thereto. As a specific example of this embodiment of the invention, one can consider a table as constituting the support surface 20 and a vibratile element, such as a sieve shaker, motor, or pump as constituting the vibratile ware 30 to be vibration isolated from the surface 20.

Accordingly, while this invention has been described in the foregoing specification in connection with certain preferred embodiments thereof, many additional variations and modifications thereof will be obvious to those skilled in the art. Thus, it is to be understood that the foregoing specification is illustrative in nature and that the scope of the invention is to be circumscribed only by the scope of the following claims.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:-

1. A vibration isolator ware, said ware:

(a) being composed of a solid resilient polymeric damping material of construction having a loss factor, η , of at least 0.2 at 20°C and 100 Hz excitation frequency, and said ware comprising;

(b) a plate element;

(c) support means depending from said plate element to space said plate element from a support surface and to define an unsupported portion of said plate element;

(d) a boss element having a free end extending upwardly from said unsupported portion of said plate element.

2. The vibration isolator ware of Claim 1 wherein said polymeric damping material of construction has a loss factor, η, of at least about 0.5.

3. The vibration isolator ware of Claim 1 wherein said polymeric damping material of construction is a polyvinylchloride composition comprising polyvinylchloride and about 118 parts per hundred by weight thereof of a highly aromatic plasticizer therefor.

4. The vibration isolator ware of Claim 1 wherein, in addition, said boss element comprises a rigid member disposed across the entire free end thereof.

5. The vibration isolator of Claim 4 wherein said rigid member comprises a stud element depending centrally therefrom and the free end of said boss element comprises a centrally located recess therein adapted to receive said stud element.

6. The vibration isolator ware of Claim 1 wherein said support means comprises a plurality of foot pods spaced at equal intervals about the periphery of said plate element to define an unsupported central portion thereof.

7. The vibration isolator ware of Claim 1 wherein said polymeric damping material of construction is an externally plasticized polymer of vinyl chloride.

8. The vibration isolator ware of Claim 1 wherein said unsupported portion of said plate element is the central portion thereof.

9. The vibration isolator ware of Claim 8 wherein the bottom surface of said unsupported central portion is concave.

10. The vibration isolator ware of Claim 8 including a centrally located aperture extending through said boss element and said plate element.

11. A vibration isolated system comprising:

(a) a support surface;

(b) a ware to be vibration isolated; and

(c) interposed between (a) and (b), a plurality of vibration isolator wares, each said isolator ware being composed of a solid resilient polymeric damping material of construction having a loss factor, η, of at least 0.2 at 20° C and 100 Hz excitation frequency and each said isolator ware further comprising:

(i) a plate element;

(ii) support means depending from said plate element to space said element from the support surface of (a) and to define an unsupported portion of said plate element; and;

(iii) a boss element having a free end extending upwardly from said unsupported portion of said plate element, said free end receiving said ware of (b) thereon;

the number of said isolator wares of (c) present being such that substantial static loading of each is provided by the mass of the ware of (b) supported thereon, thereby to generate within the polymeric damping material of construction of each of said isolator wares substantial components of shear and compression.

12. The vibration isolated system of Claim 11 wherein said ware of (b) weighs no more than about 25 kg.

13. The vibration isolated system of Claim 11 wherein the polymeric damping material of construction of said vibration isolator wares of (c) has a loss factor, η, of at least about 0.5.

14. The vibration isolated system of Claim 11 wherein the polymeric damping material of construction of said vibration isolator wares of (c) is a polyvinylchloride composition comprising polyvinylchloride and about 118 parts per hyndred by weight thereof of a highly aromatic plasticizer therefor.

15. The vibration isolated system of Claim 11 wherein each vibration isolator ware of (c) comprises a rigid member is disposed across the entire free end of said boss element of (c) (iii), said rigid members receiving said ware of (b) thereon.

16. The vibration isolated system of Claim 11 wherein said support means (c) (ii) of each vibration isolator ware comprises a plurality of foot pods spaced at equal intervals about the periphery of said plate element of (c) (i) to define an unsupported central portion thereof.

17. The vibration isolated system of Claim 11 wherein, in each of said vibration isolator wares of (c), said unsupported portion of said plate element of (i) is the central portion and the perimeter of said plate element is the supported portion.

18. The vibration isolated system of Claim 17 wherein, in each of said vibration isolation wares of (c), the bottom of said unsupported central portion of said plate element of (i) is concave.

19. The vibration isolated system of Claim 17 wherein the static loading of said vibration isolator wares of (c) by said ware of (b) is sufficient to impart to each of said wares of (c) a shear ratio, as defined herein, of at least about 6.

20. The vibration isolated system of Claim 11 wherein said ware of (b) is a phonograph turntable.

21. The vibration isolated system of Claim 11 wherein said ware of (b) is a laboratory balance.

22. A method for vibration isolating which comprises:

(a) providing a support surface;

(b) providing a ware to be vibration isolated; and

(c) interposing between said ware of (b) and said support surface of (a) a plurality of vibration isolator wares, each said isolator ware being composed of a solid resilient polymeric damping material of construction having a loss factor, η, of at least 0.2 at 20°C and 100 Hz excitation frequency and each said isolator ware further comprising:

(i) a plate element;

(ii) support means depending from said plate element to space said element from the support surface of (a) and to define an unsupported portion of said plate element; and

(iii) a boss element having a free end extending upwardly from said unsupported portion of said plate element, said free end receiving said ware (b) thereon;

the number of said isolation wares of (c) so interposed being selected such that substantial loading of each is provided by the mass of the ware of (b) supported thereon, thereby to generate within the polymeric damping material of construction of each of said isolator wares substantial components of shear and compression.

23. The method of Claim 22 wherein said ware to be vibration isolated of (b) weighs no more than about 25 kg.

24. The method of Claim 22 wherein the polymeric damping material of construction of said vibration isolator wares of (c) has a loss factor, η, of at least about 0.5.

25. The method of Claim 22 wherein the polymeric damping material of construction of said vibration isolator wares of (c) is an externally plasticized polyvinylchloride composition.

26. The method of Claim 25 wherein said polyvinylchloride composition comprises a homopolymer of vinyl chloride and about 118 parts per hundred parts by weight of said homopolymer of a highly aromatic plasticizer therefor.

27. The method of Claim 22 the number of said isolator wares of (c) interposed between the support surface of (a) and the ware to be vibration isolated of (b) is selected such that the static loading of each of said isolator wares is sufficient to impart thereto a shear ratio, as defined herein, of at least about 6.

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6-1

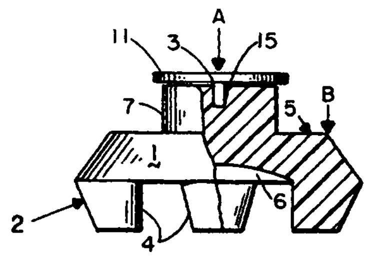

Fig. 1

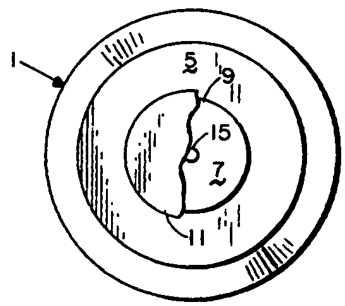

Fig. 2

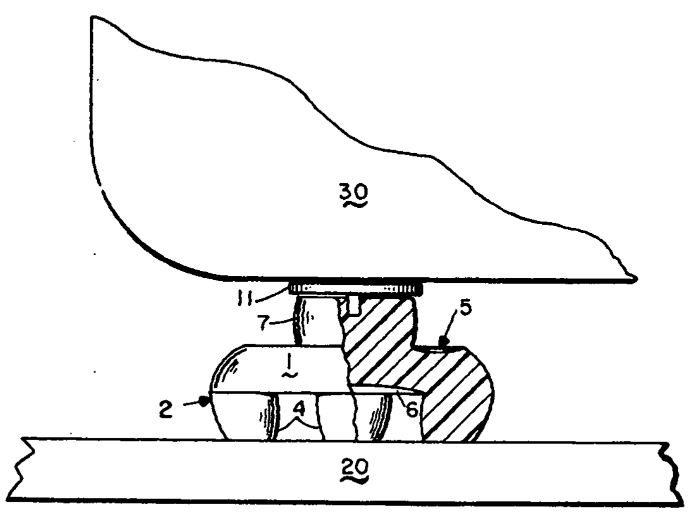

Fig. 3

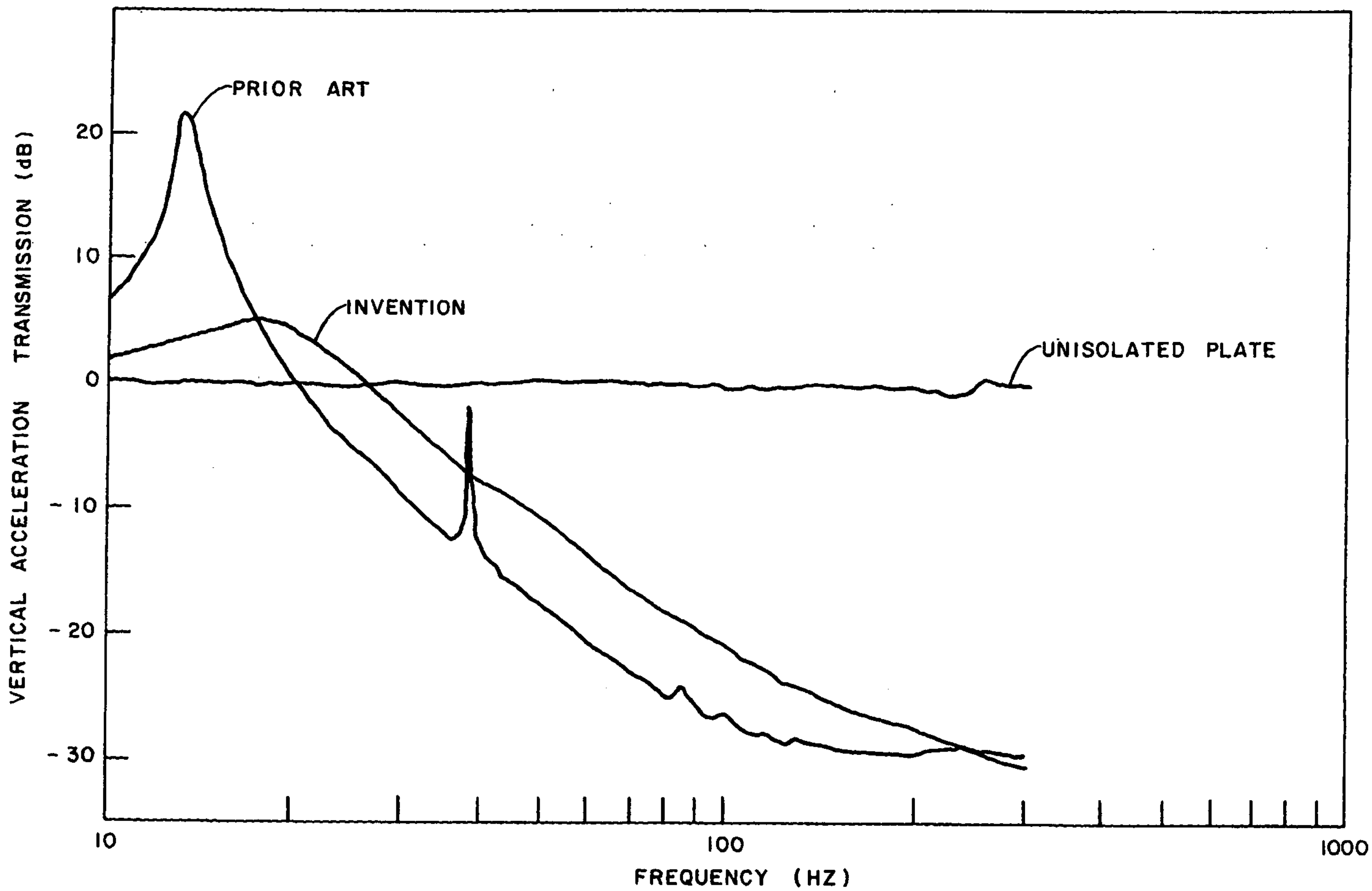
PRIOR ART
INVENTION
UNISOLATED PLATE
VERTICAL ACCELERATION TRANSMISSION (dB)
20
10
0
-10
-20
-30
10
100
1000
FREQUENCY (HZ)

Fig. 4

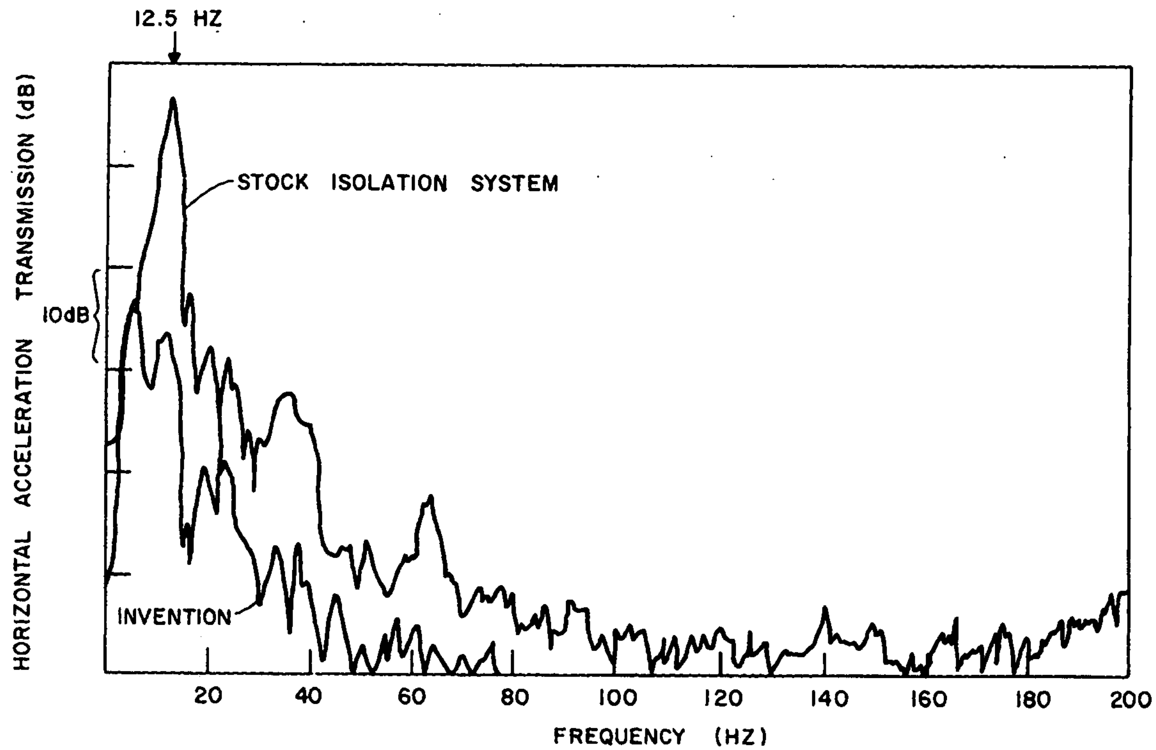
12.5 HZ
STOCK ISOLATION SYSTEM
INVENTION
10dB
HORIZONTAL ACCELERATION TRANSMISSION (dB)
20
40
60
80
100
120
140
160
180
200
FREQUENCY (HZ)

Fig. 5

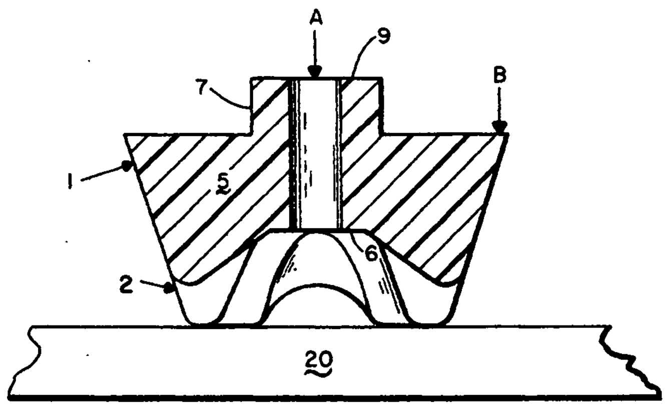

Fig. 6

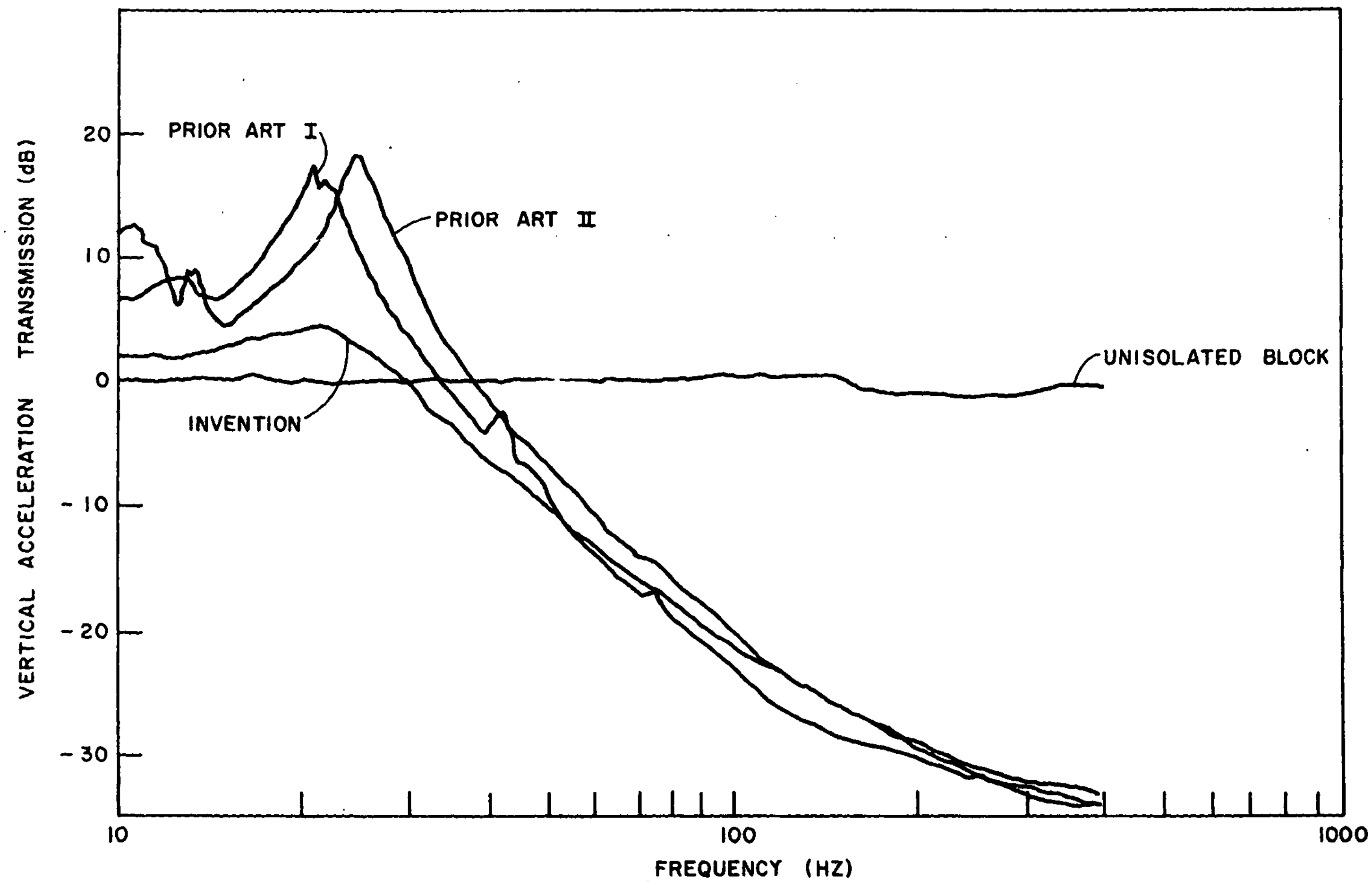
PRIOR ART I
PRIOR ART II
UNISOLATED BLOCK
INVENTION
VERTICAL ACCELERATION TRANSMISSION (dB)
20
10
0
-10
-20
-30
10
100
1000
FREQUENCY (HZ)

Fig. 7

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6-6

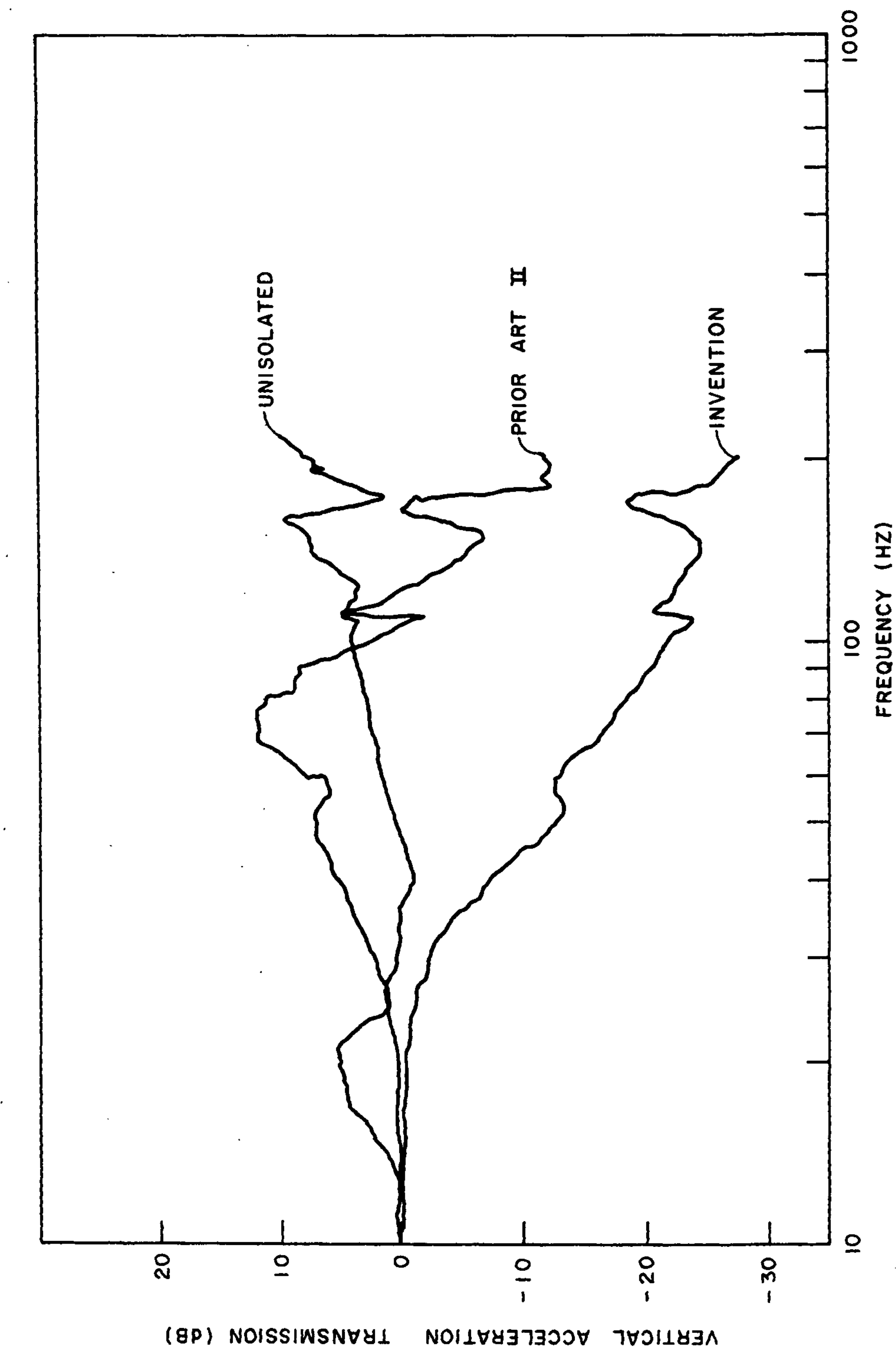

Fig. 8